11. (Amended) A method for sanding probe tips to a known extent, said method comprising the steps of [by]:

determining [the] a vertical height of at least [the lowest] a probe having the smallest vertical height of an array of probes by making contact with a planar metallic surface, [and]

[moving] positioning the array of probes over a metallic surface sanding area which is co-planar with said planar metallic surface, and

moving said metallic surface sanding area vertically toward said array of probes until electrical contact is made with the [lowest] probe in the array having the smallest vertical height, and

A3 Cont'd

further moving said metallic surface sanding area into physical and electrical contact with said array of probes to a known amount desired to provide [proper] sanding action by way of friction occurring between said probe tips and said metallic surface sanding area as said probe tips move across said metallic surface sanding area during said further movement of said metallic surface sanding area.

Please cancel claim 12 without prejudice or disclaimer.

REMARKS

Claims 1-11 are pending in the application. Claims 1, 6 and 8-11 have been amended herein and claim 12 has been cancelled. The specification has been amended to correct a minor typographical error. Favorable reconsideration of the application, as amended, is respectfully requested.

I. APPLICANTS' INVENTION

The present invention relates to a method and apparatus for testing or otherwise evaluating probe cards used for inspecting or testing integrated circuit chips in wafer form. As is described in detail in the specification, probe cards

having a plurality of probes extending therefrom are used for testing integrated circuits prior to final assembly in a corresponding integrated circuit package. Each of the probes on the probe card includes a probe tip which is used to make electrical contact with a corresponding bonding pad on the integrated circuit chip. Various tests of the integrated circuit can then be performed.

The alignment and positioning of the probes in the probe cards are particularly important in view of the need to maintain proper alignment of each probe tip with the corresponding bonding pad when testing the integrated circuit chips. As a result, it is necessary that the probes on the probe card be in proper alignment and exhibit acceptable scrub mark patterns to allow for proper testing of the integrated circuit chips. The present invention provides a system which can test the locations of the probes on the probe card without requiring an actual wafer or film representation of the bonding pads on the integrated circuit chip. In a preferred embodiment, the present invention includes a video camera which inspects the position of each probe tip as the probes are engaged in contact with the flat surface of a window. A computerized positioning table with X, Y and Z position controls enables the video camera to obtain a digital image of each probe tip through the window. By computer processing these images, the locations of each of the probe tips are determined relative to each other. This location information is then used to automatically evaluate characteristics of one or more bus probes included in the probes.

In another embodiment, the video camera provides a digital image of a probe contacting the surface of the window in a first state where the probe tip is driven in contact with a first force and a second state where the probe tip is driven in contact with the window with a second force, the second force being different than the first force. The location of the probe tip is evaluated in both states to

determine a location and length of the scrub mark provided by the probe tip. This information is useful for determining what the actual locations of the probe tips would be when the probe card is applied to an integrated circuit chip for testing. The prior art does not teach or suggest such features in a system for inspecting probe cards. These and other advantages of the present invention will become even more apparent in view of the discussion provided below.

II. FORMAL REJECTIONS

The Examiner states in the Office Action that the Background section of the present application improperly identifies the patent number for the reference cited on page 4, line 6 of the specification. The citation has been corrected as is noted above in the amendment to the specification. Enclosed for the Examiner's convenience is a Supplemental Information Disclosure Statement correctly identifying the reference and providing a copy thereof.

Claims 1-12 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite. The Examiner refers to a number of ambiguities in the claims as requiring correction. In response, the claims have been carefully reviewed and amended in an effort to eliminate any ambiguity and indefiniteness which may be perceived. Special emphasis has been placed on addressing each of the Examiner's concerns stated in the Office Action in addition to providing further clarification where deemed appropriate.

In view of the above noted amendments to the claims, it is believed that the claims now fully and concisely define that which the Applicants regard as their invention. As a result, withdrawal of the rejection under 35 U.S.C. §112, second paragraph, is respectfully requested.

The specification has also been objected to under 35 U.S.C. §112, first paragraph, as failing to provide an enabling disclosure in relation to the sanding of probe tips as is recited in claim 11. Similarly, claim 11 stands rejected under 35 U.S.C. §112, first paragraph, based on the same reasons as the objection to the specification.

The Examiner contends that while the specification has disclosed various processes for determining the location of probes, determining the scrub marks, and other processing of the image of a probe, there does not appear to be any disclosure directed to the sanding of the probe tips. However, the Examiner's attention is directed to Figure 3 of the application which discloses a small area sanding plate 140 provided on the chuck 100. (See, e.g., spec., pg. 18, lines 4-7). The sanding area can be used to sand the probe tips by moving the sanding area into physical contact with the probes. (See, e.g., pg. 9, lines 15-23).

Accordingly, it is respectfully submitted that the specification does in fact provide disclosure directed to the sanding of the probe tips. As a result, withdrawal of the objection to the specification and the rejection of claim 11 under 35 U.S.C. §112, first paragraph, is respectfully requested.

With respect to the objection to the drawings under 37 C.F.R. §1.83(a), the Examiner's attention is again directed to Figure 3 which identifies the sanding area 140. Thus, it is respectfully submitted that the drawings do show every feature of the invention specified in the claims. Withdrawal of the objection to the drawings is also requested.

III. REJECTION OF CLAIMS 1-2, 4, 6 AND 9 UNDER 35 U.S.C. §102(b)

Claims 1-2, 4, 6 and 9 stand rejected under 35 U.S.C. §102(b) as being anticipated by Sato et al. This rejection is respectfully traversed for at least the following reasons.

Sato et al. relates to a wafer prober with the ability to orient and to position a probe card and wafer automatically to assure the best alignment of the probes on the card to the pads on the wafer. It does not address the testing of the probe card for proper positioning of its probes with respect to each other in addition to testing other parameters on the card such as planarity, contact resistance, gram force, etc. The Sato et al. device makes use of two cameras and requires the presence of a wafer in conjunction with the probe card. One camera is viewing the wafer and the other is viewing the probe tips. Various calibration techniques are used to reference the two cameras with respect to each other. The system takes the position of the "corner" probes as representative and uses these or some other limited set to establish position to the pads on the integrated circuit. It uses the pattern of probes read by the camera as a map to search for bonding pad locations on the wafer with the second camera by using the probe positions to qualify candidates, then verifying the presence of a bonding pad by image processing techniques. Movements of the probe card and the wafer are then executed to move the two into proper alignment with each other.

According to the present invention as defined in claim 1, the integrated circuit probe inspection system includes a viewing system and window for determining the relative positions of the probes in the probe array. In addition, the system includes automated means for evaluating the characteristics of at least one bus probe included in the probes based on the relative positions. For example, a bus probe pin 130 is used to contact the bus probes in order to differentiate

therebetween. Sato et al. does not teach or suggest facilities for such evaluation of the probe card since the probe card in Sato et al. is being used, not tested. Thus, Sato et al. fails to teach or suggest an integrated circuit probe card inspection system as set forth in amended claim 1.

With respect to amended claim 6, there is no teaching or suggestion regarding a circuit probe card inspection system which determines the location and length of the scrub mark which would be made by the probe tip on an integrated circuit bonding pad. More particularly, claim 6, as amended, calls for the viewing system to obtain a digital image of the probe tip through the window in a first state where the probe tip is driven in contact with the window with a first force. In a second state, the probe tip is driven in contact with the window with a second force different from the first force while the digital image is provided. A computerized means analyzes the position of the probe tip within the digital image in the first and second states and determines the location and the length of the scrub mark based on the positions. This aspect of the invention is best exemplified in Figures 6(a)-6(c) of the drawings.

Claim 9, on the other hand, relates to a method for learning the probe tip locations for a plurality of probe tips in an existing known good probe card. In particular, a digitized image of each probe tip on the probe card is captured and the relative position of each probe tip is then determined with respect to the other probe tips on the probe card. A file of the relative position information is constructed for use in determining the correct placement of probe tips on other probe cards of a same type. Sato et al. teaches only the feature of identifying the location of probe tips using a video camera but does not teach or suggest a method for accumulating a file of relative position information for use in identifying the correct placement of probe tips on other probe cards. Sato et al. is concerned

only with matching the probe card in its present, non-overdriven, state to the wafer.

For at least the above reasons, it is respectfully submitted that claims 1-2, 4, 6 and 9 are not anticipated by Sato et al. Withdrawal of the rejection is respectfully requested.

IV. REJECTION OF CLAIMS 3, 5, 7, 8 AND 10-12 UNDER 35 U.S.C. §103

Claims 3, 5, 7, 8 and 10-12 stand rejected under 35 U.S.C. §103 as being unpatentable over Sato et al. in view of Chang et al. This rejection is respectfully traversed for at least the following reasons.

Chang et al. relates to a real-time apparatus for detecting surface defects on objects. The Examiner contends that it would have been obvious based on the teachings of Chang et al. to modify Sato et al. to analyze an image for defects like scrub marks. However, the Examiner seems to believe that a scrub mark is a "defect" that the present invention is searching for and trying to correct or eliminate. This is not the case. The scrub mark is a normal result of putting the hard probe down on the soft aluminum contact pad and overdriving it. The scrub and consequent mark is desirable and necessary to break through the aluminum oxide which builds up on the surface of the probe. The present invention evaluates the location and length of the scrub mark to confirm that it is sufficient. The scrub mark, in such case, is not a defect but rather is desired.

Accordingly, with respect to claim 7, there is no teaching or suggestion in Sato et al. or Chang et al. regarding the determining the path and form of the scrub mark as claimed. With regard to claim 8, neither Sato et al. nor Chang et al. teaches or suggests measuring the length of a probe tip extending from a probe

shank as claimed. Claim 8 defines an apparatus in which a contacting means sequentially contacts a distal end of the probe tip and the shank from which the probe tip extends. A measuring means measures the vertical height of each contacted point and a calculating means determines the difference in the two measured heights in order to determine the length of the probe tip. This aspect of the invention is best exemplified in Figs. 7a and 7b.

Regarding claim 10, Sato et al. and Chang et al., whether viewed alone or in combination, do not teach or suggest the specific method recited for determining the orientation and spatial position of an array of probes. There is no teaching or suggestion of moving the field of view of a video microscope in a predetermined direction not exceeding the X or Y dimension of the array, and then, if no probes are found, moving along the opposite direction and along the positive and negative directions of the other axis until probes are found in the field of view. With regard to claim 11, the Examiner contends that it would have been obvious to one having ordinary skill in the art to perform a sanding operation as claimed. However, the Examiner does not cite a single reference which would suggest such obviousness. Applicants respectfully submit that Chang et al. and Sato et al. do not teach or suggest the provision of a sanding area as claimed in any way whatsoever.

Accordingly, withdrawal of the rejection of claims 3, 5, 7, 8 and 10-11 is respectfully requested.

V. CONCLUSION

For at least the above reasons, all claims pending in the application are believed to be allowed and the application in condition for allowance. A prompt action to such end is earnestly solicited.

Should the Examiner feel that a telephone interview would be helpful to facilitate favorable prosecution of the above-identified application, the Examiner is invited to contact the undersigned at the telephone number provided below.

Should any fees be due as a result of the filing of this response, the Commissioner is hereby authorized to charge the Deposit Account No. 18-0988.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR

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CERTIFICATE OF MAILING

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231.

January 16, 1995
DATE